Performance of a subkm and urban version of the Global Environmental Multiscale (GEM) atmospheric model for Toronto's 2015 Pan American Games

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An experimental version of the Global Environmental Multiscale (GEM) atmospheric model was integrated from May 1rst to August 31st 2015 in support to the Pan American Games that took place in Toronto, Canada. The numerical integrations were performed for 24-h each day, initialized at 0600 UTC (0200 local time), with grid spacings of 2.50-km, 1.00-km, and 0.25-km. In contrast with its operational implementations, the PanAm GEM was run with increased vertical resolution near the surface (first level at 5 m above the surface) and with urban processes represented by the Town Energy Balance (TEB) scheme.

Near-surface observations from the extensive observational network that was specifically installed for the Games are used in this study to provide an objective evaluation of GEM's near-surface temperature, humidity, wind, and precipitation forecasts. This type of objective evaluation has rarely been done for subkm atmospheric models due to the large number of numerical integrations that is required to achieve statistically significant results. The evaluation indicates that decreasing grid spacing from 2.50 km to 0.25 km leads to substantial reductions of errors, especially for the standard deviation (random) component. The positive impact is found for all variables, although there seems to be some issues for near-surface winds that could be related to the specification of the canopy roughness length over urban areas.

In addition to these standard meteorological variables, the Pan American version of GEM also produced forecasts of comfort indices over natural and urban areas, at street level and over roofs, in shaded and sunlit areas. The indices produced by GEM, of interest for health applications, are the Wet-Bulb Globe Temperature (WBGT) and the Universal Thermal Climate Index (UTCI). Subjective evaluation for these outputs reveals the difficulties associated with such variables that requires accurate prediction of several aspects like temperature, humidity, and downward incident radiation (with links to the mean radiant temperature).